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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:
Yodhiro IWASA
Serial No: Not assigned
Filed: September 1, 2000
For: SEMICONDUCTOR DEVICE

Box PATENT APPLICATION
Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Transmitted herewith for filing is the patent application identified above.

- [x] 3 sheet(s) of drawings ([ ] formal [x] informal) is(are) enclosed.
- [x] 12 page(s) of specification and 1 page(s) of abstract of the invention are enclosed.
- [ ] An assignment of the invention to SEIKO EPSON CORPORATION [ ] is enclosed [x] will follow.
- [ ] An associate power of attorney [ ] is enclosed [ ] will follow.
- [ ] A verified statement to establish small entity status under 37 C.F.R. 1.9 and 1.27 is enclosed.
- [ ] Declaration and Power of Attorney [ ] is enclosed [x] will follow.
- [ ] A certified copies of Japanese Patent Application No. 11-252252 filed September 6, 1999, 2000-243735 filed August 11, 2000 from which priority is claimed under 35 U.S.C. § 119 will follow.
- [x] IDS enclosed ([x] with 4 reference(s)).
- [ ] Preliminary Amendment is enclosed.
- [x] Return postcard is enclosed.

CALCULATION OF FEES

	ITEM	TOTAL NO. OF CLAIMS		NO. OF CLAIMS OVER BASE	LG/SM $ ENTITY FEE		$ AMOUNT	$ FEE
A	TOTAL CLAIMS FE E	11	-20	0	LG=$18 SM=$9	$18	0	
B	INDEPENDENT CLAIMS FEE*	1	-3	0	LG=$78 SM=$39	$78	0	
C	SUBTOTAL - ADDITIONAL CLAIMS FEE (ADD FINAL COLUMN IN LINES A + B)							0
D	MULTIPLE-DEPENDENT CLAIMS FEE						LARGE ENTITY FEE = $260 SMALL ENTITY FEE = $130	$ 0
E	BASIC FEE						LARGE ENTITY FEE = $690 SMALL ENTITY FEE = $345	$ 690
F	TOTAL FILING FEE (ADD TOTALS FOR LINES C, D, AND E)							$ 0
G	ASSIGNMENT RECORDING FEE						$ 40	$ 40
	*LIST INDEPENDENT CLAIMS 1.							

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Respectfully submitted,
HOGAN & HARTSON L.L.P.

Date: September 1, 2000

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PATENT
Attorney Docket No: 81754.0040

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:	Art Unit: Not assigned
Yoshiro IWASA	Examiner: Not assigned
Serial No: Not assigned	
Filed: September 1, 2000	
For: SEMICONDUCTOR DEVICE	

CERTIFICATE OF MAILING VIA U.S. EXPRESS MAIL
"Express Mail" Mailing Label No. EL 589 805 155 US
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Dear Sir:

I hereby certify that

- ☒ two copies of a letter of transmittal
- ☒ patent application (12 page(s) of specification; 11 claim(s); 1 page(s) of abstract
- ☒ 3 sheet(s) of informal drawings
- ☒ Information Disclosure Statement with 4 references
- ☒ return postcard

are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service with sufficient postage under 37 C.F.R. § 1.10 on the date indicated above and are addressed to:

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Date: September 1, 2000

James Hernandez
Name of person mailing papers

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#4

F005359US00

SEMICONDUCTOR DEVICE

Field of Industrial Utility

The present invention relates to a semiconductor device, and more particularly to a semiconductor device that is capable of correctly transferring signals at high speed.

Prior Art

Conventionally, a wiring pattern of printed conductor lines and the like is formed on a product system substrate. A plurality of semiconductor chips are mounted on the system substrate, and electrode pads are formed on the semiconductor chips for transferring electric signals. The electrode pads are electrically connected to lead frames by bonding wires. The semiconductor chip, the bonding wires and one end of the lead frames are sealed with resin. On the other hand, the other end of the lead frames is connected to the wiring pattern by soldering or pressure bonding. Electrical signals are transferred (inputted and outputted) between the semiconductor chips through the wiring pattern and the lead frames.

In the conventional semiconductor device described above, digital signals are generated by turning ON and OFF of electrical signals, and such signals are transferred.

As a result, there are problems in that the semiconductor device is likely to be affected by noises that may result from factors such as higher frequency, higher operation speed and lower voltage (2V) operation. Also, malfunctions may possibly occur due to other factors such as voltage fluctuations.

Furthermore, in the conventional semiconductor device described above, portions of the lead sections that protrude from the mold resin (i.e., the semiconductor package) are connected to the wiring pattern on the system substrate by soldering or pressure bonding, and electrical signals that

are transferred by the wiring pattern are inputted in or outputted from the semiconductor chips.

As a result, the electrical signals are substantially influenced by physical properties of transfer elements (physical properties of copper or the like) of the wiring pattern. Therefore, there is a problem in that it is difficult to continuously maintain the original characteristics of the signals. In other words, harmful effects may be created by the influences of the physical properties of adjacent wirings, such as wiring capacitances and the like. As a result, for example, propagating signals may be blunted, their amplitudes may become unstable, and devices in succeeding stages may malfunction.

In particular, circuits for clock signals that are inputted in and outputted from the semiconductor device must be designed in consideration of the harmful effects. Also, since electrical influences among adjacent signal lines cannot be ignored, malfunction protection circuits and other signal controls may need to be implemented. Moreover, the leads that protrude from the semiconductor package have a limited degree of freedom with respect to their length and positions, and therefore, the leads can only be connected to limited areas on the system substrate.

SUMMARY OF THE INVENION

Therefore, it is an object of the present invention to provide a semiconductor device that can accurately transmit signals at high speed.

In accordance with one embodiment of the present invention, a semiconductor device includes a semiconductor chip, a light-receiving element formed on the semiconductor chip for receiving optical signal, and an optical signal transfer device connected to the light-receiving element for transferring the optical signal into the semiconductor chip.

In accordance with this embodiment, the optical signal transfer device is connected to the semiconductor chip through the light-receiving element, such that optical signals are used as signals that are inputted in the

semiconductor chip. Optical signals have a smaller attenuation of signal amplitude and have a higher transfer speed compared to electrical signals. Therefore, correct signal transfer becomes possible, and thus signals can be correctly transferred at high speed.

The optical signal transfer device may be formed from an optical fiber, such as, for example, a glass fiber.

Also, the semiconductor device may further include a package that seals the semiconductor chip and a portion of the optical fiber.

Also, the semiconductor chip may be mounted on a mounting substrate.

Also, in accordance with another embodiment of the present invention, a semiconductor device includes a mounting substrate, an optical signal transfer device disposed in the mounting substrate for transferring optical signals, a plurality of semiconductor chips mounted on the mounting substrate, and a light-receiving element connected to the optical signal transfer device for receiving optical signals, wherein signals are transferred among the plurality of semiconductor chips by the optical signal transfer device.

Furthermore, in accordance with another embodiment of the present invention, a semiconductor device includes a semiconductor chip, a light-receiving element formed on the semiconductor chip for receiving optical signals, and an optical signal transfer device connected to the light-receiving element for transferring signals from an arithmetic processing apparatus as optical signals into the semiconductor chip.

In accordance with this embodiment, the optical signal transfer device is connected to the semiconductor chip through the light-receiving element, such that optical signals are used as signals that are inputted from the arithmetic processing apparatus in the semiconductor chip. Optical signals have a smaller attenuation of signal amplitude and have a higher transfer

speed compared to electrical signals. Therefore, correct signal transfer becomes possible, and thus signals can be correctly transferred at high speed.

In particular, when clock signals are used as signals that are inputted from the arithmetic processing apparatus in the semiconductor chip, phase shifts in the clock signals can be avoided, and highly accurate clock signals can be transferred to the semiconductor chip.

Also, the optical signal transfer device may be provided in a mounting substrate on which the semiconductor chip is mounted. For example, the optical signal transfer device may be embedded in the mounting substrate.

Also, a light-emitting element surface that is formed on the mounting substrate or within the mounting substrate may be used as the optical signal transfer device. In other words, for example, the light-emitting element surface is formed on the mounting substrate, such that the entire surface of the mounting substrate may irradiate light in response to inputted optical signals. As a result, the optical signal transfer device can be disposed anywhere in the mounting substrate without regard to the mounting location of the semiconductor chip within the mounting substrate.

Alternatively, instead of forming a light-emitting element surface over the entire surface of the mounting substrate, the optical signal transfer device may be formed in a lattice configuration, and disposed in the mounting substrate.

In this instance, the light-receiving element in a convex shape may be formed on the semiconductor chip on a side thereof that is opposite to the mounting substrate. The light-receiving element may be inserted in the optical signal transfer device that is disposed in a plane configuration or a lattice configuration to thereby connect the light-receiving element to the optical signal transfer device. As a result, the light-receiving element and the optical signal transfer device can be readily and securely connected to each other.

BRIEF DESCRIPTOIN OF THE DRAWINGS

Fig. 1 is a cross-sectional view in part of a semiconductor device in accordance with a first embodiment of the present invention.

Fig. 2 is a cross-sectional view in part of a semiconductor device in accordance with a second embodiment of the present invention.

Fig. 3 schematically shows a plan view of a semiconductor device in accordance with a third embodiment of the present invention.

Fig. 4 schematically shows a plan view of a semiconductor device in accordance with a fourth embodiment of the present invention.

Fig. 5 is a view for illustrating a method for connecting a light-emitting element or a light-receiving element with a glass fiber.

Fig. 6 schematically shows a plan view of a semiconductor device in accordance with a fifth embodiment of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

Embodiments of the present invention are described below with reference to the accompanying drawings.

Fig. 1 is a cross-sectional view in part of a semiconductor device in accordance with a first embodiment of the present invention.

The semiconductor device has a semiconductor chip 11. A light-receiving element (not shown) is formed on the semiconductor chip 11 for receiving optical signals carried on a laser beam (infrared light) or the like. The light-receiving element is connected to one end of an optical signal transfer device, such as, for example, a glass fiber 15 that is a directional element by a light-transmissive type adhesive. The optical signal transfer device transfers optical signals into the semiconductor chip 11. The semiconductor chip 11, the light-receiving element and one end of the glass fiber 15 are sealed by molding resin 13.

In the semiconductor device described above, optical signals are guided from the glass fiber 15 through the light-receiving element into the semiconductor chip 11. In other words, the optical signals are handed over by the light-receiving element and introduced in the semiconductor chip 11.

In accordance with the first embodiment of the present invention, the glass fiber 15 is connected to the semiconductor chip 11 through the light-receiving element, and optical signals carried by laser are used as signals that are inputted in the semiconductor chip 11. Optical signals have a smaller attenuation of signal amplitude and have a higher transfer speed compared to electrical signals. Therefore, accurate signal transfer becomes possible, and thus signals can be correctly transferred at high speed with substantially no effects by the physical property (transmission property) of the glass fiber 15 that is an optical signal transfer device.

Also, optical signals are difficult to be affected by noises than electrical signals, and therefore malfunctions that may be cause by voltage fluctuations are also difficult to occur. Furthermore, optical signals are not affected by the physical properties of a transfer element such as the glass fiber 15, and can continuously maintain the original characteristics of the signal.

Also, optical signals do not become blunt due to the influences of the physical properties existing among the adjacent glass fibers, and their amplitudes do not become unstable.

In the first embodiment described above, one end of the glass fiber 15 and the light-receiving element are connected by a light transmissive type adhesive. However, one end of the glass fiber 15 and the light-receiving element can be connected by pressure bonding by molding.

Fig. 2 is a cross-sectional view in part of a semiconductor device in accordance with a second embodiment of the present invention, in which the semiconductor chip 11 shown in Fig. 1 is mounted on a system substrate that is a mounting substrate.

A plurality of electrode pads 23 are formed on a surface of the semiconductor chip 11. Part of the electrode pads 23 are electrically connected to leads 26 through 30 by bonding wires. Another part of the electrode pads 23 is connected to one end of the glass fiber 15 as an optical signal transfer device through the light-receiving element. The semiconductor chip 11, the bonding wires 25, a part of the leads, and one end of the glass fiber 15 are sealed by the molding resin 13.

Wiring patterns 36 – 39 of conductive lines are printed on the system substrate 21. Also, a semiconductor package 13 is mounted on the system substrate 21. Portions of the leads 26 – 30 that protrude from the semiconductor package 13 are connected to the wiring patterns 36 – 39 by soldering or pressure bonding.

In the semiconductor device described above, optical signals are inputted through the glass fiber 15, and the optical signals are changed into electrical signals within the semiconductor chip 11. For example, it is possible to set such that a power supply potential V_{DD} is supplied from a power source to a signal line that supplies electrical signals that have been converted from optical signals in response to an optical signal ON, and a ground potential is supplied to the signal line in response to an optical signal OFF.

The second embodiment can produce effects similar to those of the first embodiment.

Also, in the second embodiment, the glass fiber 15 is connected to the semiconductor chip 11. As a result, the degree of freedom in disposing the circuit elements is improved compared with a device using only leads. More specifically, portions of the leads that protrude from the semiconductor package 13 have fixed length and are disposed at fixed locations, such that the leads can be connected to the wiring patterns at limited locations on the system substrate 21. Also, a gap L between the wiring patterns 36 and 37 on the system substrate 21 needs to be greater than a specified amount.

Accordingly, the circuit structure is restricted when only the leads and the wiring patterns are used. However, when the glass fiber 15 is additionally used as a means to supply signals to the semiconductor chip 11, the degree of freedom in disposing the circuit components is improved.

Also, a gap between the adjacent leads (pins) needs to be greater than a specified amount. Since the number of the pins cannot limitlessly be increased, the circuit structure is restricted. However, the additional use of the glass fiber 15 as a means to supply signals to the semiconductor chip 11 improves the degree of freedom in disposing the circuit components.

It is noted that, in the second embodiment, one glass fiber 15 is connected to the semiconductor chip 11. However, a plurality of glass fibers may be connected to the semiconductor chip, and the glass fibers can be disposed at any locations.

Fig. 3 schematically shows a plan view of a semiconductor device in accordance with a third embodiment of the present invention.

Directional elements such as glass fibers 45 – 47 are disposed in a system substrate 41as a means to transfer optical signals. A plurality of semiconductor chips 42 and 43 are mounted on the system substrate 41. Light-receiving elements for receiving optical signals carried on a laser beam (infrared light) or the like and light-emitting elements for emitting optical signals 51 – 56 are formed on the semiconductor chips 42 and 43.

The semiconductor chips 42 and 43 are connected to each other by the glass fibers 45 – 47 through the light-receiving elements and light-emitting elements 51 – 56. The glass fibers are used in the same manner as wirings such as conduction wirings.

More specifically, one end of the glass fiber 47 is connected to the semiconductor chip 42 through the light-receiving element 51, and the other end of the glass fiber 47 is connected to the semiconductor chip 43 through the light-emitting element 52, such that signals are outputted from the semiconductor chip 43 to the light source semiconductor chip 42. Also, one

end of the glass fiber 46 is connected to the semiconductor chip 42 through the light-receiving element 53, and the other end of the glass fiber 46 is connected to the semiconductor chip 43 through the light-emitting element 54. One end of the glass fiber 45 is connected to the semiconductor chip 42 through the light-emitting element 55, and the other end of the glass fiber 45 is connected to the semiconductor chip 43 through the light-receiving element 56, such that signals are outputted from the semiconductor chip 42 to the semiconductor chip 43.

In the semiconductor device described above, optical signals are transferred between the semiconductor chips 42 and 43 through the glass fibers 45 – 47 and the light-receiving elements 51 – 56. In other words, optical signals are handed over and introduced in the semiconductor chips 42 and 43 by the light-receiving elements 51 – 56.

Therefore, the third embodiment provides effects similar to those provided by the first embodiment.

In particular, when clock signals are transferred between an arithmetic processor apparatus and a memory apparatus, the embodiment provides favorable effects because a phase shift does not occur in the clock signal.

Also, in accordance with the third embodiment, wirings with a directional material such as glass fibers 45 – 47, as a wiring material for connecting semiconductor products, are pre-installed within the system substrate 41. Therefore, lead sections that are typically used in a conventional semiconductor device are not required. Accordingly, malfunctions of the device that may be caused by defective soldering can be prevented.

Fig. 4 shows a semiconductor device in accordance with a fourth embodiment of the present invention.

In the fourth embodiment, a system substrate 61 is formed from a film substrate, for example. Glass fibers 62 as an optical signal transfer device

are connected in a lattice structure and embedded in the system substrate 61. When a signal is generated at any one location of the glass fibers 62, the signal can be propagated through the entire area of the glass fibers 62. When the system substrate 61 is formed, the glass fibers 62 are embedded in the system substrate 61.

An arithmetic processor apparatus 63 is mounted on the system substrate 61. A light-emitting element 67 to transferring a clock signal is formed on the arithmetic processor apparatus 63. There are provided semiconductor chips such as storage apparatuses 64 and 65 that receive clock signals from the arithmetic process apparatus 63. Light-receiving elements 68 and 69 are formed on the storage apparatuses 64 and 65 for receiving optical signals carried on laser beam (infrared light) or the like. Contact holes 61a are formed in the system substrate 61 that is formed with the glass fibers 62 described above at locations where the semiconductor chips 63 – 65 are mounted and in a manner that the contact holes 61a are located opposite to the light-receiving elements or the light-emitting elements 67 – 69. Then, the light-receiving elements and light-emitting elements 67 – 69 are inserted in the contact holes 61a, and the light-receiving elements and light-emitting elements 67 – 69 are pressure bonded to the glass fibers 62, as shown in Fig. 5, to thereby connect the light-receiving elements and light-emitting elements 67 – 69 to the glass fibers 62.

As a result, the semiconductor chips 63 – 65 are connected to the glass fibers 62 through the light-receiving elements and light-emitting elements 67 – 69. Clock signals from the semiconductor chip 63 that is an arithmetic processor apparatus are transferred through the light-emitting element 67 to the glass fibers 62, and the semiconductor chips 64 and 65 receive the signals transmitted through the glass fibers 62 at their respective light-receiving elements 68 and 69. As a result, the clock signals are taken into the storage apparatuses 64 and 65 from the glass fibers 62.

Signals other than the clock signals may be transferred by wiring patterns that may be formed on the system substrate 61, for example.

Accordingly, this embodiment also provides effects similar to those provided by the embodiments described above. Also, in the semiconductor device of the present embodiment, the glass fibers 62 in a lattice configuration are formed in the system substrate 61. Therefore, when the system substrate 61 is formed, glass fibers 62 do not need to be embedded in consideration of factors such as locations of semiconductor chips to be mounted on the system substrate 61. As a result, the system substrate 61 can be readily manufactured.

Also, since the system substrate 61 is formed by a film substrate, the system substrate 61 can be bent to a degree, and the cost can be lowered.

It is noted that the fourth embodiment is described with reference to a structure in which the glass fibers 62 are formed through the entire area of the system substrate 61. However, the present invention is not limited to this embodiment. For example, the glass fibers 62 may be formed in a limited area in the system substrate 61, for example, in an area where the semiconductor chip is mounted.

Also, the smaller the gap of the lattice becomes, the less the position of the glass fibers needs to be considered when the semiconductor chip is mounted. However, the lattice gap may be determined depending on separations among the semiconductor chips that are mounted on the substrate.

Fig. 6 shows a semiconductor device in accordance with a fifth embodiment of the present invention.

In accordance with the fifth embodiment of the present invention, a system substrate 71 is used instead of the system substrate 61 used in the apparatus of the fourth embodiment.

The system substrate 71 of the fifth embodiment is formed from a film substrate, and a light-emitting surface 72 composed of light-emitting

elements such as light-emitting diodes formed on the system substrate 71. A light prevention film is formed on the light-emitting surface 72 for preventing external light from entering into the light-emitting surface 72.

It is noted that the light-emitting surface 72 may be formed within the system substrate 71. Alternatively, the system substrate 71 may be formed from light-emitting elements, and the system substrate 71 may be used as the light-emitting surface 72.

Contact holes 71a are formed in the system substrate 71 at locations where the semiconductor chips 63 – 65 are mounted in a manner that the contact holes 71a are disposed opposite to the light-receiving elements or light-emitting elements 67 – 69. The light-receiving elements and light-emitting elements 67 – 69 are inserted in the contact holes 71a, and the light-receiving elements and light-emitting elements 67 – 69 are pressure bonded to the light-emitting surface 72 to thereby connect the light-receiving elements and light-emitting elements 67 – 69 to the light-emitting surface 72.

As a result, the semiconductor chips 63 – 65 are connected to the light-emitting surface 72 through the light-receiving elements and light-emitting elements 67 – 69. Clock signals from the semiconductor chip 63 that is an arithmetic processor apparatus are transferred through the light-emitting element 67 to the light-emitting surface 72, and the semiconductor chips 64 and 65 receive the signals transmitted from the light-emitting surface 72 at their respective light-receiving elements 68 and 69. As a result, the clock signals are taken into the storage apparatuses 64 and 65 from the light-emitting surface 72.

Signals other than the clock signals may be transferred by wiring patterns that may be formed on the system substrate 71, or on the light-emitting surface 72 if such a film is formed on the system substrate 71, for example.

Accordingly, this embodiment also provides effects similar to those provided by the fourth embodiment. Also, in the semiconductor device of the

present embodiment, the light-emitting surface 72 is formed on the entire area of the system substrate 71. Therefore, when semiconductor chips are mounted on the system substrate 71, mounting locations of the semiconductor chips do not need particular consideration. In contrast, particular consideration is required when glass fibers are disposed.

It is noted that the fifth embodiment is described with reference to the case where the light-emitting surface 72 is formed over the entire area of the system substrate 71. However, the present invention is not limited to such an embodiment. The light-emitting surface 72 may be formed only in a limited area in the system substrate 71, for example, in an area where the semiconductor chips are formed.

Also, a plurality of light-emitting surfaces 72 may be formed in layers. and signals are allocated to each of the layers, such that not only the clock signals but also other signals, such as, for example, enable signals may be transferred. In this case, for example, a light prevention film may be formed between the adjacent light-emitting surfaces not only to prevent external light from coming into the light-emitting surfaces but also to prevent optical signals of one light-emitting surface from coming into the other light-emitting surface. Also, the light-receiving elements and the light-emitting elements may be formed in such a manner that signals are transmitted only to the corresponding light-emitting surface or signals are received only from the corresponding light-emitting surface, and that optical signals are not transferred to the non-corresponding light-emitting surface and optical signals are not received from the non-corresponding light-emitting surface.

It is noted that the present invention is not limited to the embodiments described above, and a variety of modifications can be implemented.

<u>WHAT IS CLAIMED IS</u>:

1. A semiconductor device comprising:

a semiconductor chip and a light-receiving element formed in the semiconductor chip for receiving an optical signal; and

an optical signal transfer device connected to the light-receiving element for transferring the optical signal into the semiconductor chip.

2. A semiconductor device according to claim 1, wherein the optical signal transfer device is an optical fiber.

3. A semiconductor device according to claim 2, further comprising a package that seals the semiconductor chip and a part of the optical fiber.

4. A semiconductor device according to claim 1, wherein the semiconductor chip is mounted on a mounting substrate.

5. A semiconductor device comprising:

a mounting substrate and an optical signal transfer device disposed in the mounting substrate for transferring an optical signal;

a plurality of semiconductor chips mounted on the mounting substrate; and

a light-receiving element formed in the semiconductor chip and connected to the optical signal transfer device for receiving the optical signal,

wherein the signal is transferred among the plurality of semiconductor chips through the optical signal transfer device.

6. A semiconductor device comprising:

a semiconductor chip and a light-receiving element formed on the semiconductor chip for receiving an optical signal; and

an optical signal transfer device connected to the light-receiving element for transferring the signal from an arithmetic processing apparatus as an optical signal into the semiconductor chip.

7. A semiconductor device according to claim 6, wherein the signal is a clock signal.

8. A semiconductor device according to claim 6, wherein the optical signal transfer device is provided in a mounting substrate on which the semiconductor chip is mounted.

9. A semiconductor device according to claim 6, wherein the optical signal transfer device is a light-emitting surface that is formed in the mounting substrate.

10. A semiconductor device according to claim 6, wherein the optical signal transfer device is formed in a lattice configuration and disposed in the mounting substrate.

11. A semiconductor device according to claim 8, wherein the light-receiving element is formed in a convex shape on the semiconductor chip on a side thereof that is opposite to the mounting substrate, and the light-receiving element is inserted in the optical signal transfer device to thereby connect the light-receiving element to the optical signal transfer device.

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ABSTRACT

A semiconductor device that is capable of correctly transferring signals at high speed. The semiconductor device includes a semiconductor chip, a light-receiving element formed in the semiconductor chip for receiving an optical signal, and a glass fiber as an optical signal transfer device connected to the light-receiving element for transferring the optical signal into the semiconductor chip. Optical signals have a smaller attenuation of signal amplitude and have a higher transfer speed compared to electrical signals. Therefore, by transferring signals in the form of optical signals, the semiconductor device that can correctly transfer signals at high speed is obtained.

Fig. 1

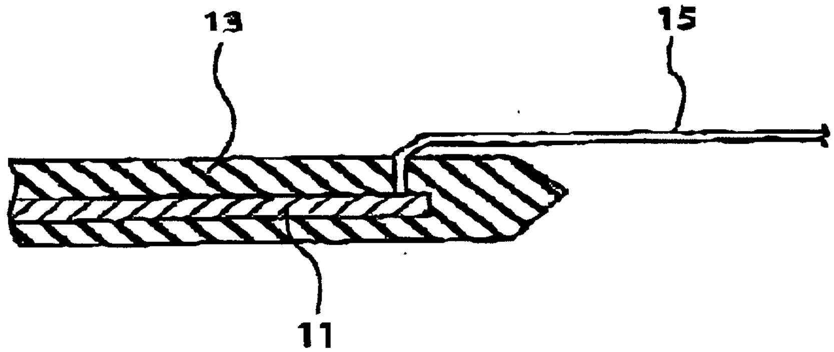


Fig. 2

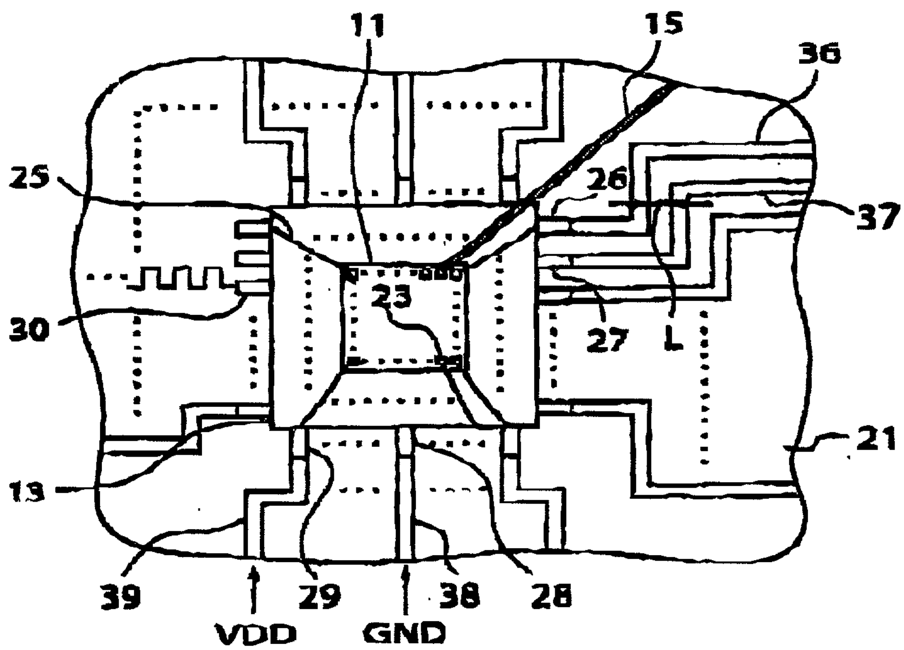


Fig. 3

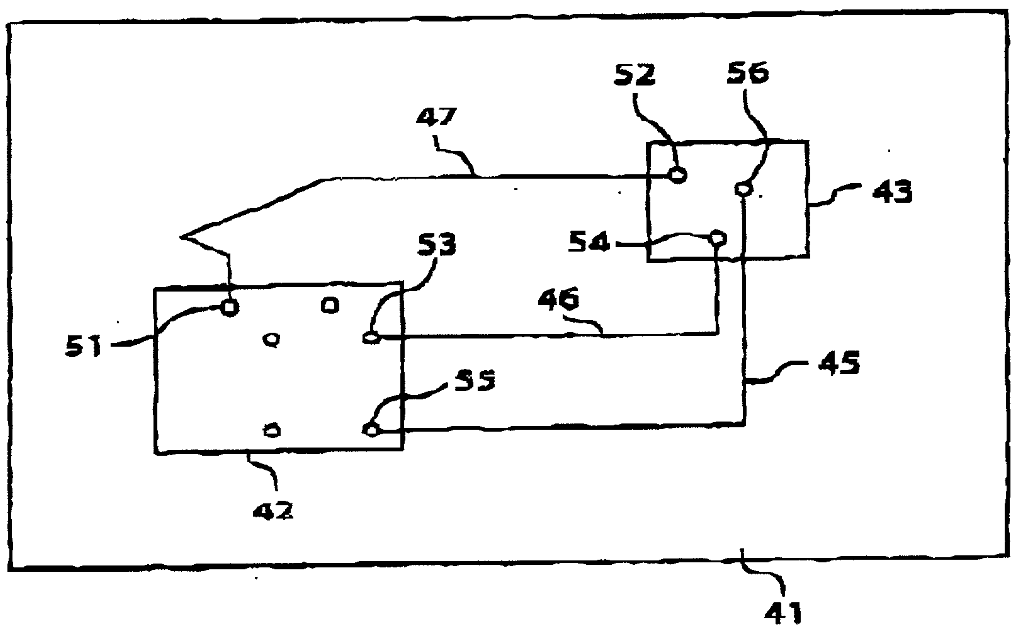


Fig. 4

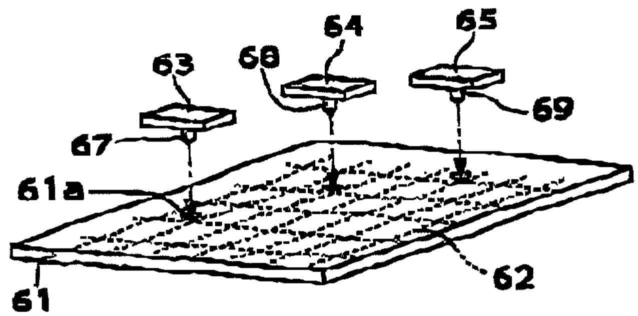


Fig. 5

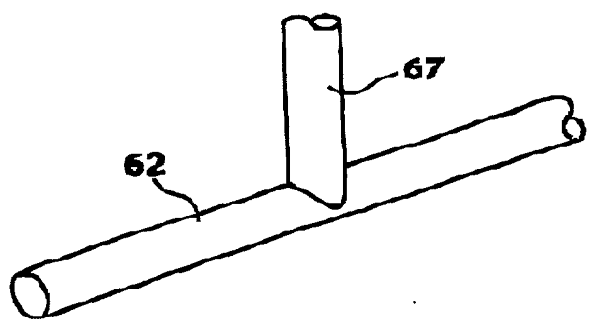
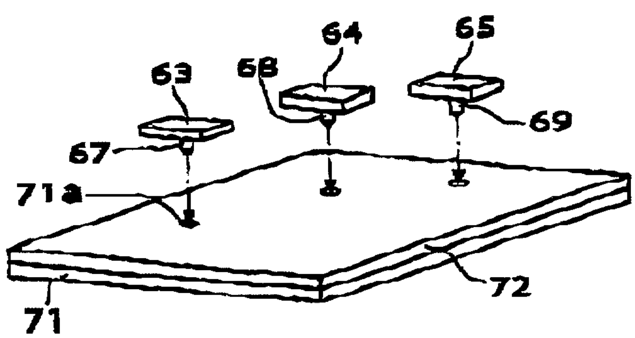


Fig. 6



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Seiko Epson Ref. No.: F005359US00 Attorney's Ref. No.: 81754.0040

Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は、下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

半導体装置

SEMICONDUCTOR DEVICE

上記発明の明細書（下記の欄で×印がついていない場合は、本書に添付）は、

the specification of which is attached hereto unless the following box is checked:

☒ 2000年9月1日に提出され、米国出願番号または特許協定条約 国際出願番号を 09/654,550 とし、（該当する場合） _____ に訂正されました。

☒ was filed on September 1, 2000 as United States Application Number or PCT International Application Number 09/654,550 and was amended on _____ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

PTO/SB/106 (8-96)
Approved for use through 9/30/98 OMB 0651-0032
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Japanese Language Declaration
(日本語宣言書)

私は、米国法典第３５編１１９条（ａ）－（ｄ）項又は３６５条（ｂ）項に基き下記の、米国以外の国の少なくとも１ケ国を指定している特許協力条約３６５条(ａ)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	Priority Not Claimed 優先権主張なし
11-252252	Japan	September 6, 1999	☐
2000-243735	Japan	August 11, 2000	☐

私は、第３５編米国法典１１９条(ｅ)項に基いて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, Section 119 (e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Application No.) (出願番号)	(Filing Date) (出願日)

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I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365 (c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application:

(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration
(日本語宣言書)

委任状： 私は、下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。（弁護士、または代理人の氏名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

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